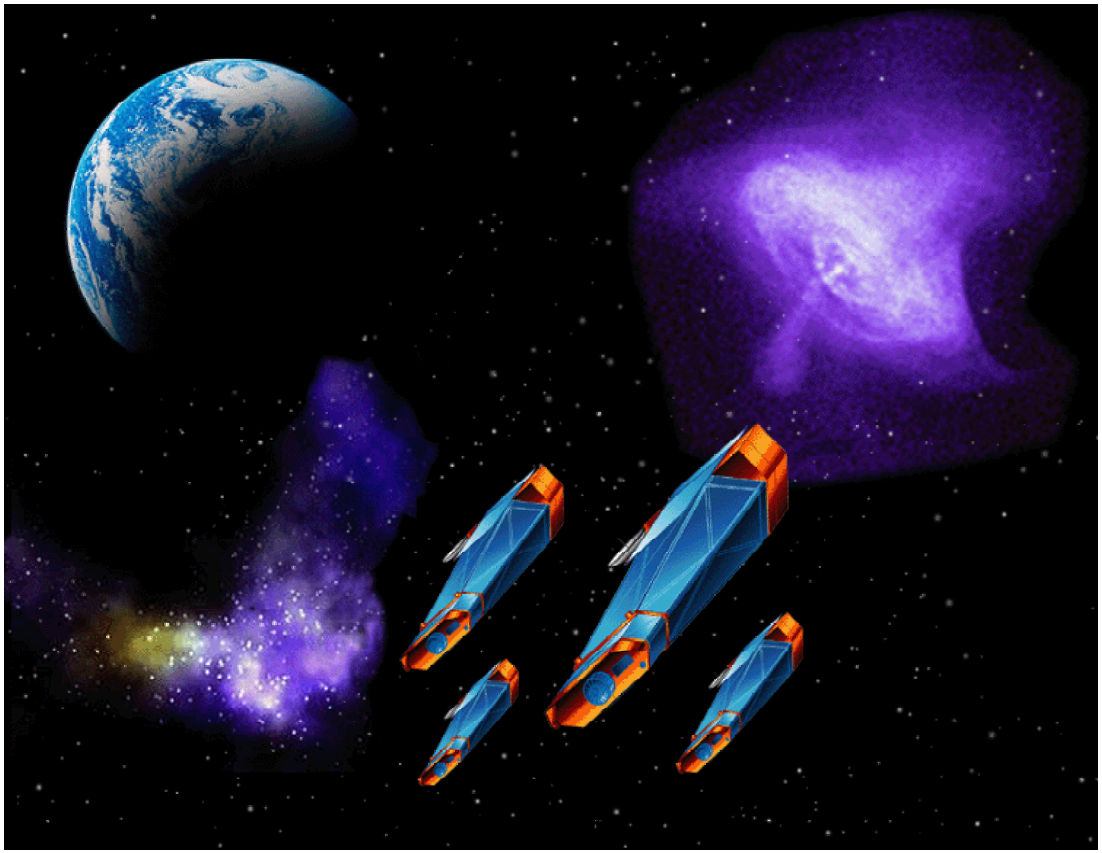
Constellation-X
Technology Development Roadmap and Critical Technology Milestones



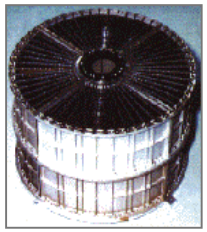
October 29, 2001

Jean Grady

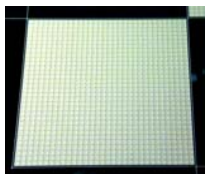
Goddard Space Flight Center

http://constellation.gsfc.nasa.gov

Constellation-X Summary Technology Roadmap

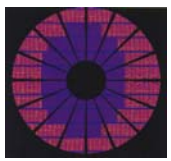


X-ray Mirrors



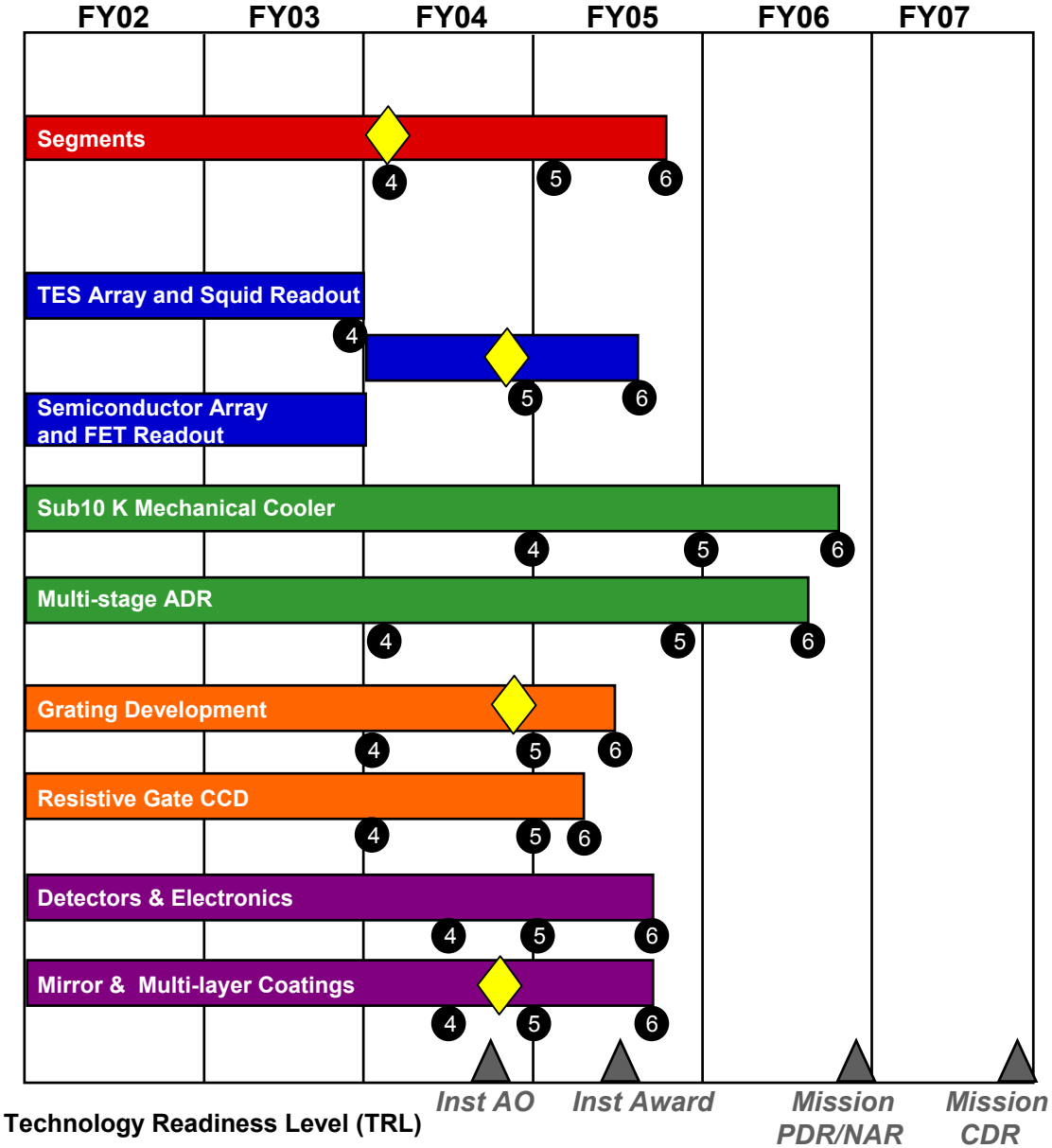
X-ray Calorimeters

Cryocoolers



Grating/CCD

Hard X-ray Telescope



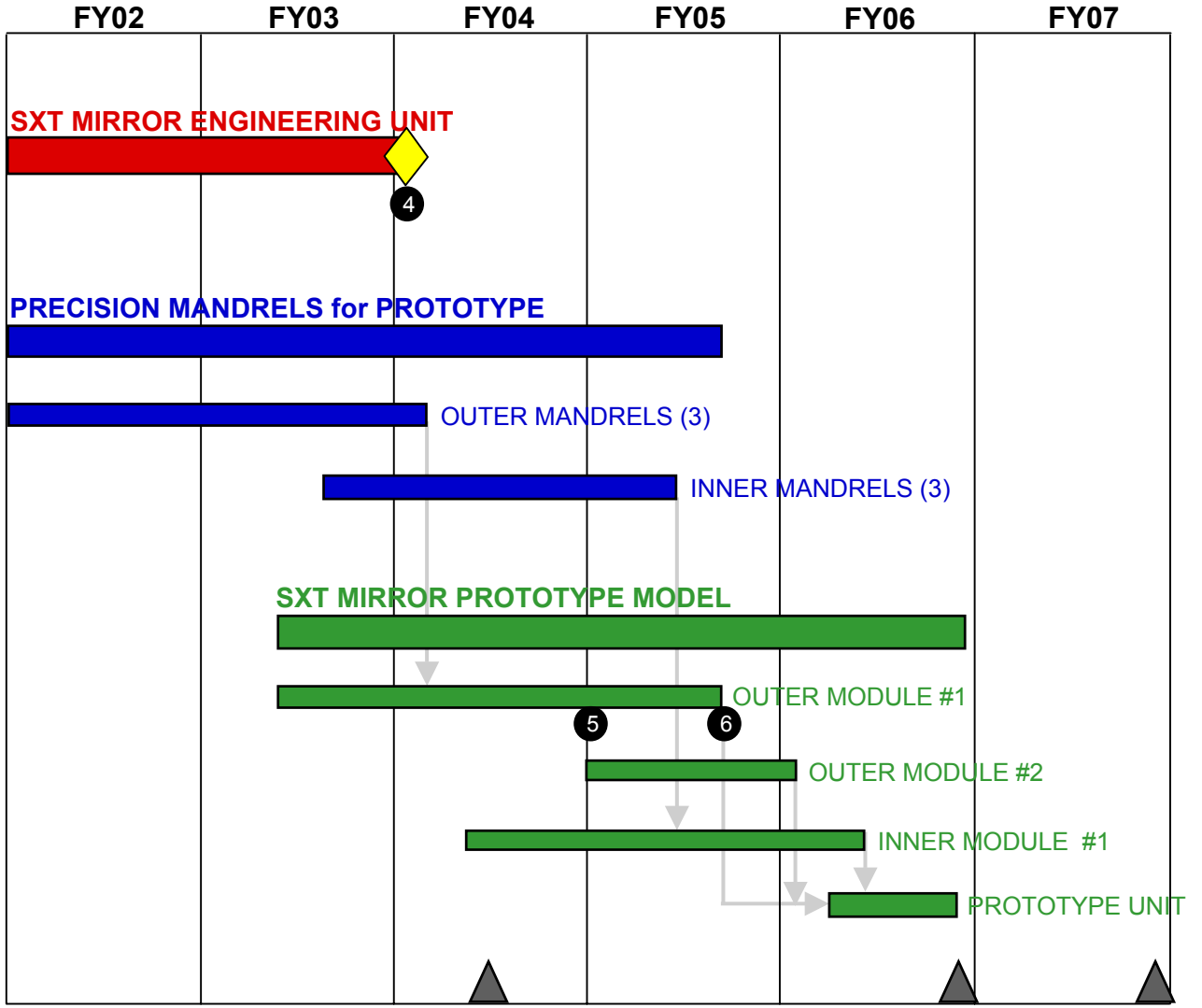
◆ Critical Technology Milestone

(#) Technology Readiness Level (TRL)

Critical Technology Development Milestones

Milestone	Date
Spectroscopy X-ray Telescope (SXT) Optic Engineering Unit	1Q FY04
Small X-ray Calorimeter Array	3Q FY04
Flight Representative Lightweight Grating Substrates	4Q FY04
Hard X-ray Telescope (HXT) Optics Demonstration Unit	4Q FY04

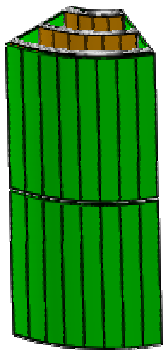
SXT Optic Technology Roadmap



◆ Critical Technology Milestone # Technology Readiness Level (TRL)

SXT Strawman Design

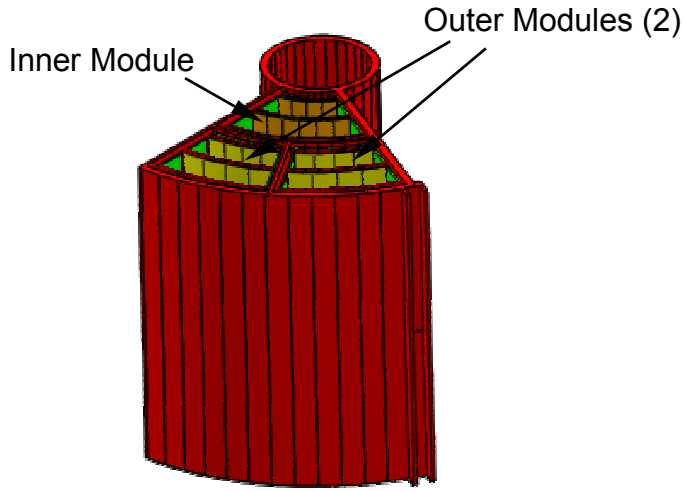
Engineering Unit



Single inner module with

- 0.5 m dia. reflector pair (replicated from Zeiss precision mandrel)
- Parabolic (P) and Hyperbolic (H) submodules
- First modules to be aligned using etched silicon microcombs

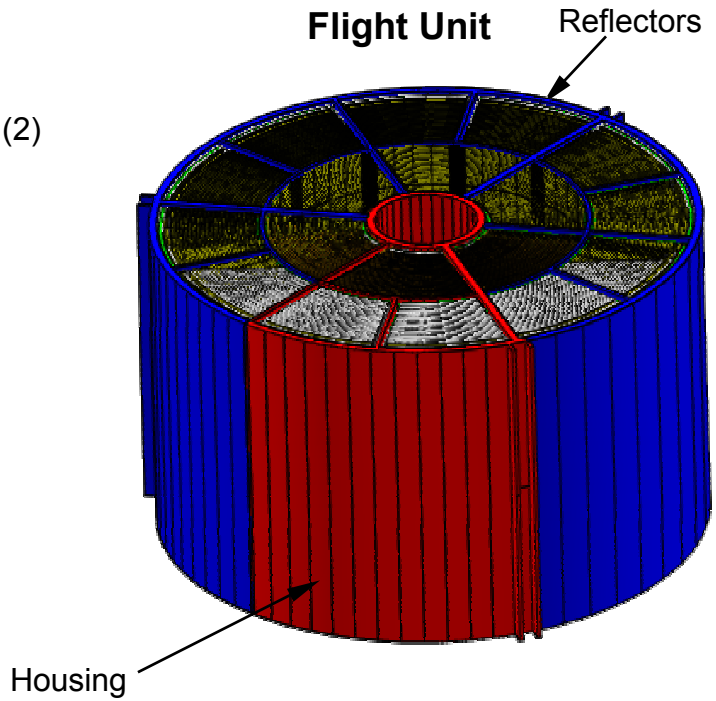
Prototype Unit



Flight Scale Assembly of

- 3 modules (2 outer and 1 inner)
- Largest diameter same as for flight - 1.6 m
- Each module has 3 to 9 reflector pairs
- Demonstrates module to module alignment

Flight Unit



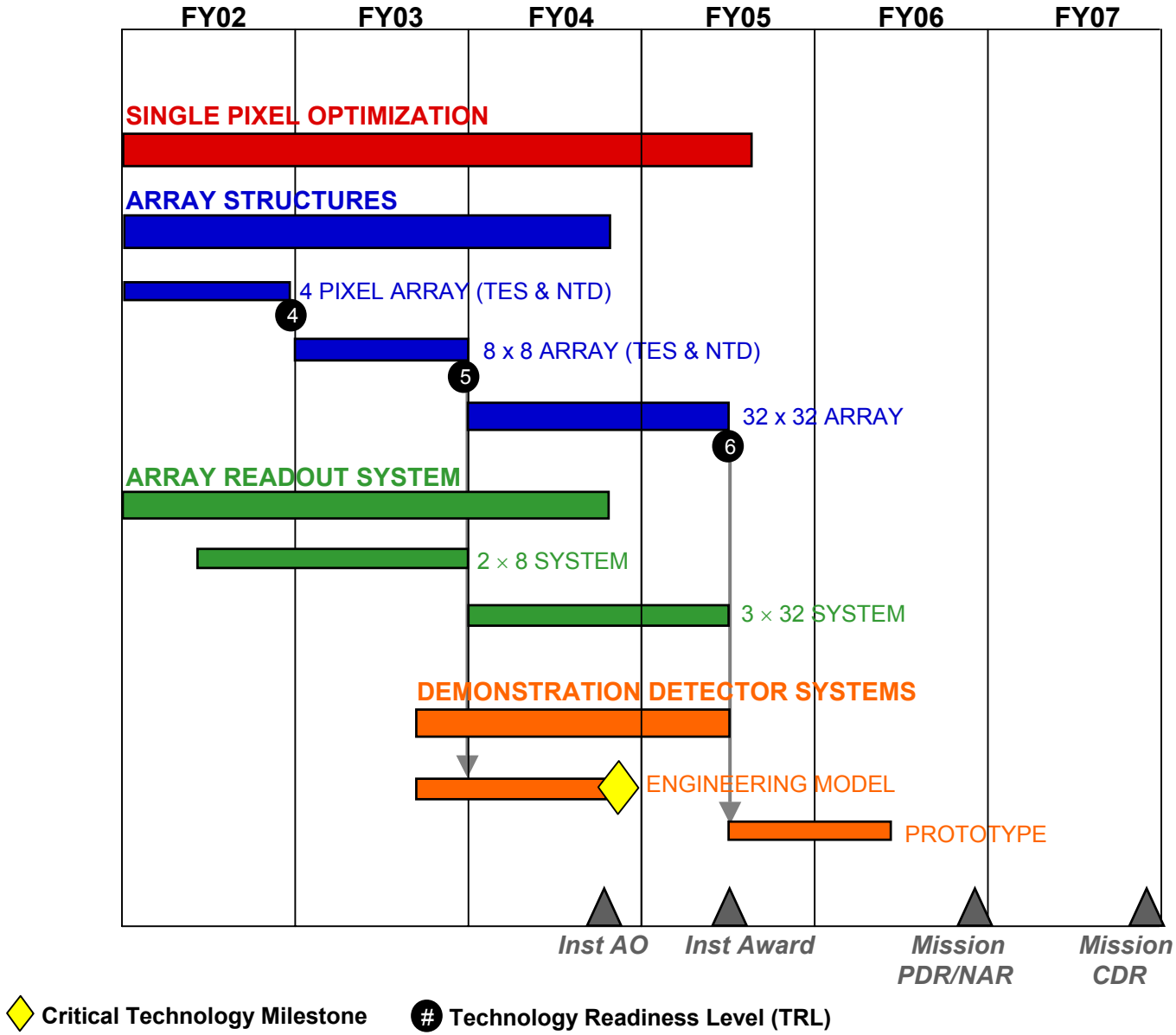
Full flight Assembly

- 1.6 m outer diameter
- 18 Small Modules
- 70 to 170 reflector diameters

SXT Optic Critical Technology Milestone

- **SXT Optic Engineering Unit Completed and Tested in X-rays**
  - Alignment comb fabrication process verified.
  - Assembly and alignment procedures established.
  - Optical performance understood and extendable to 10 arc sec.
  - Replication process satisfies requirements and is reproducible.
  - Reflector support concept verified.
  - Preliminary mechanical testing satisfactorily completed.

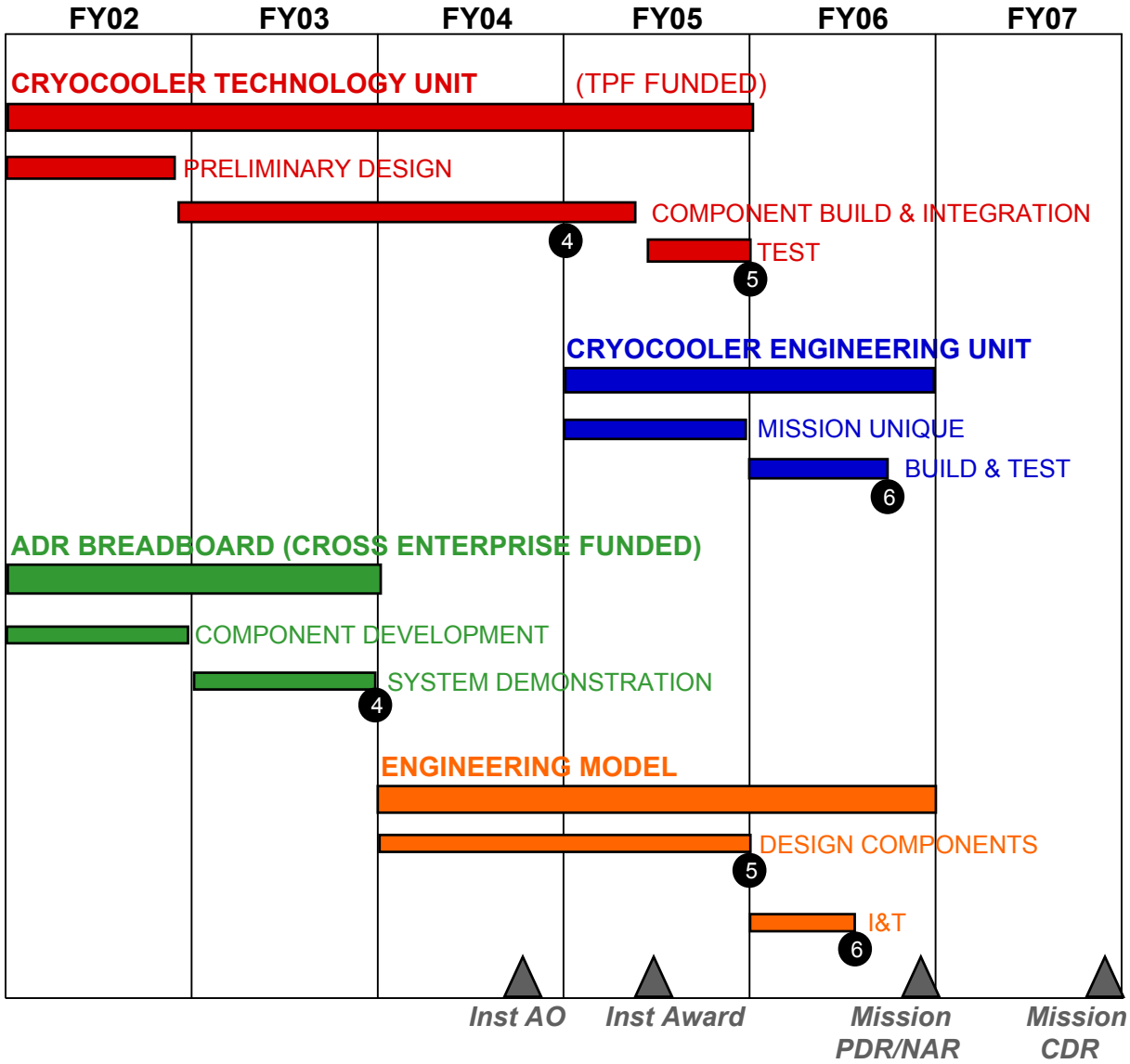
X-ray Calorimeter Technology Roadmap



X-ray Calorimeter Critical Technology Milestone

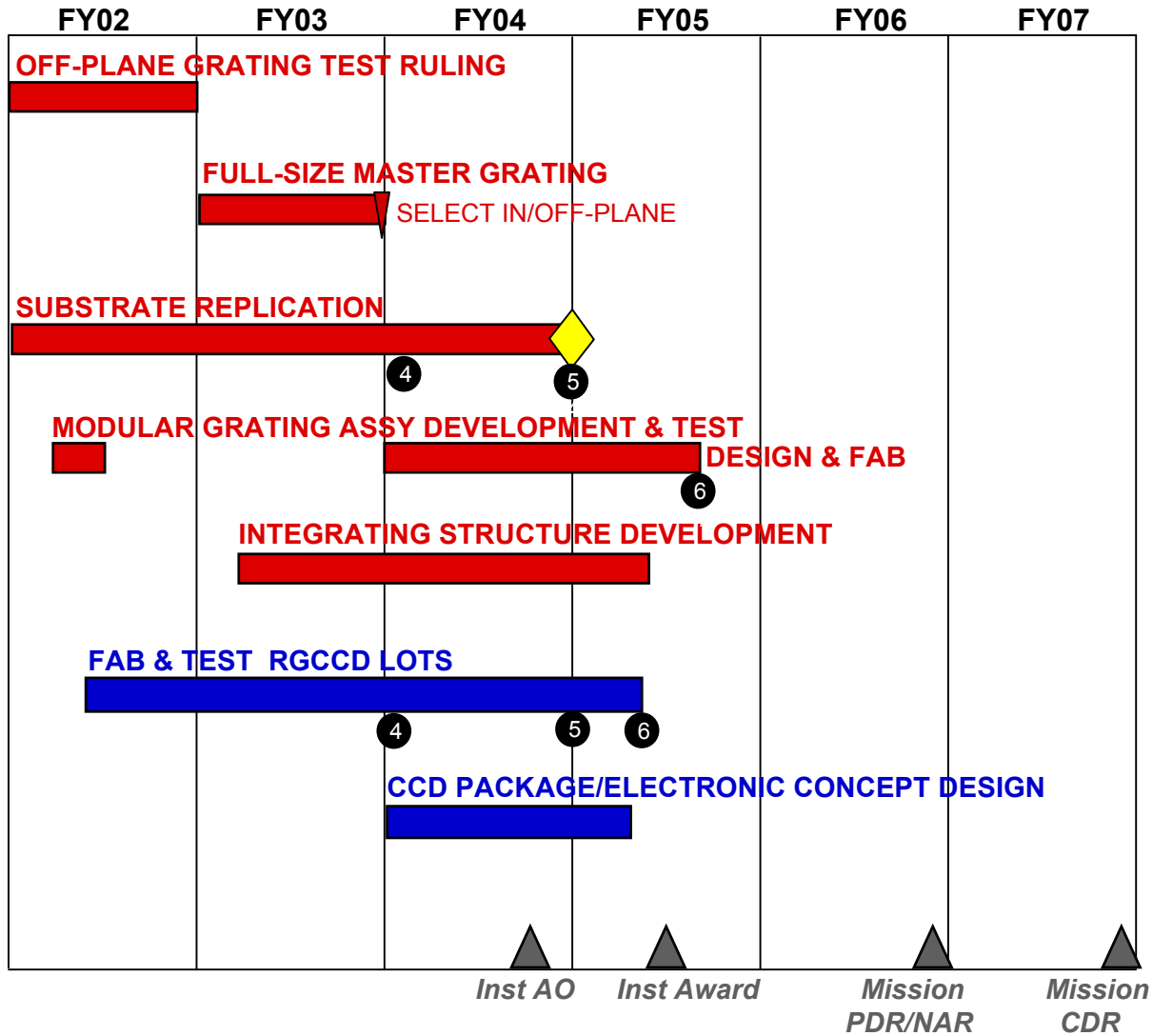
- **Small X-ray Calorimeter Array Fabricated and Tested**
  - Pixel scale and quantum efficiency appropriate to Constellation-X baseline requirements.
  - Energy resolution of 2 eV at 1.5 keV and 4 eV or better at 6 keV, simultaneously in each pixel.

Cryocooler and ADR Technology Roadmap



◆ Critical Technology Milestone # Technology Readiness Level (TRL)

Grating/CCD Technology Roadmap

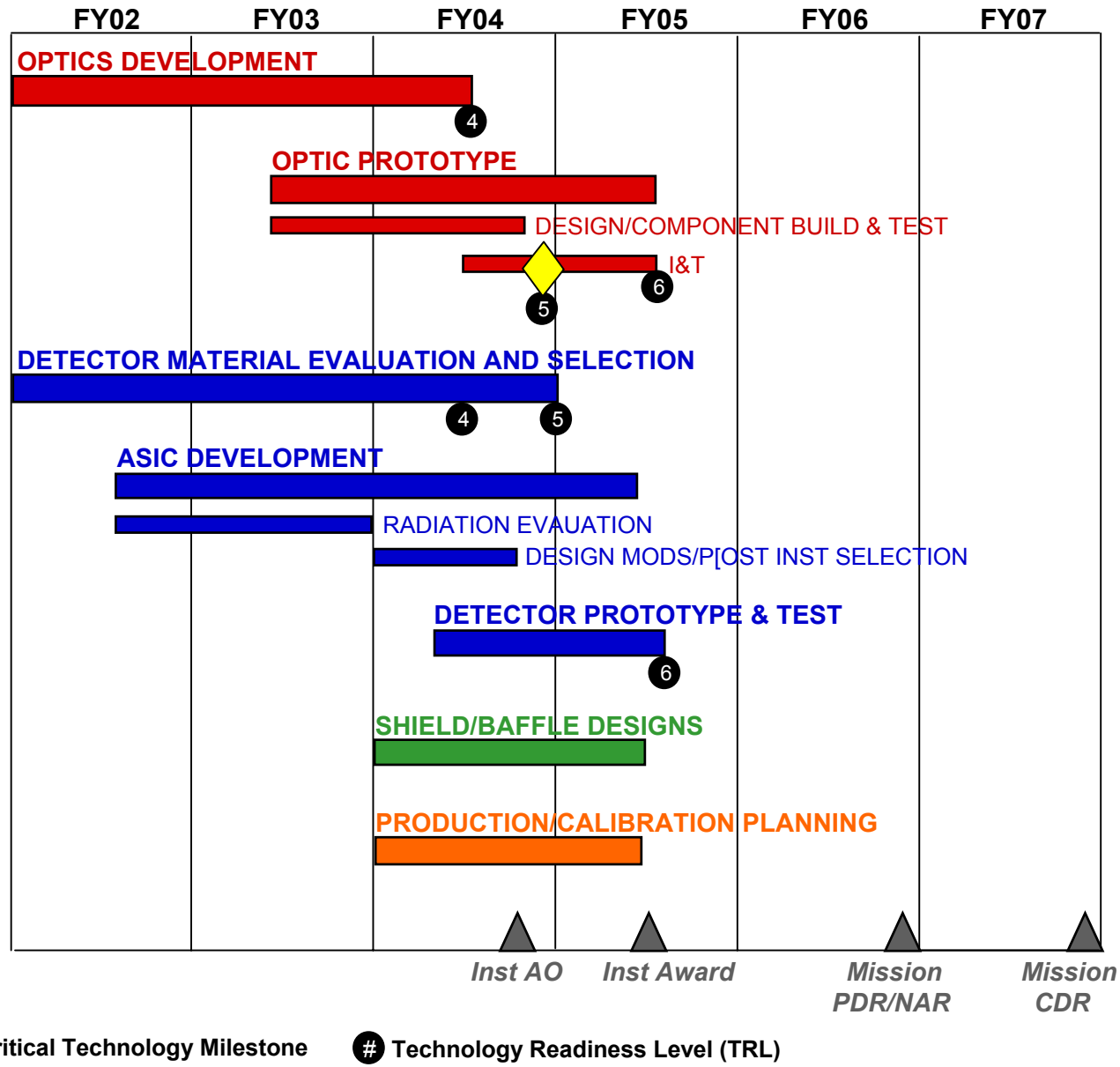


◆ Critical Technology Milestone # Technology Readiness Level (TRL)

Grating Critical Technology Milestone

- **Assembly of Three Flight Representative Lightweight Grating Substrates**
  - Substrates fabricated use procedures that can be applied to mass production and experience all processing steps that are included in the plan for the final flight gratings.
  - Substrate mass per unit area $\leq$ 0.2 gm/cm^2.
  - Substrate as-assembled flatness $\leq$ 2 arc-seconds in the dispersion direction.
  - Substrate mutual alignment $\leq$ 2 arc-seconds in the dispersion direction.

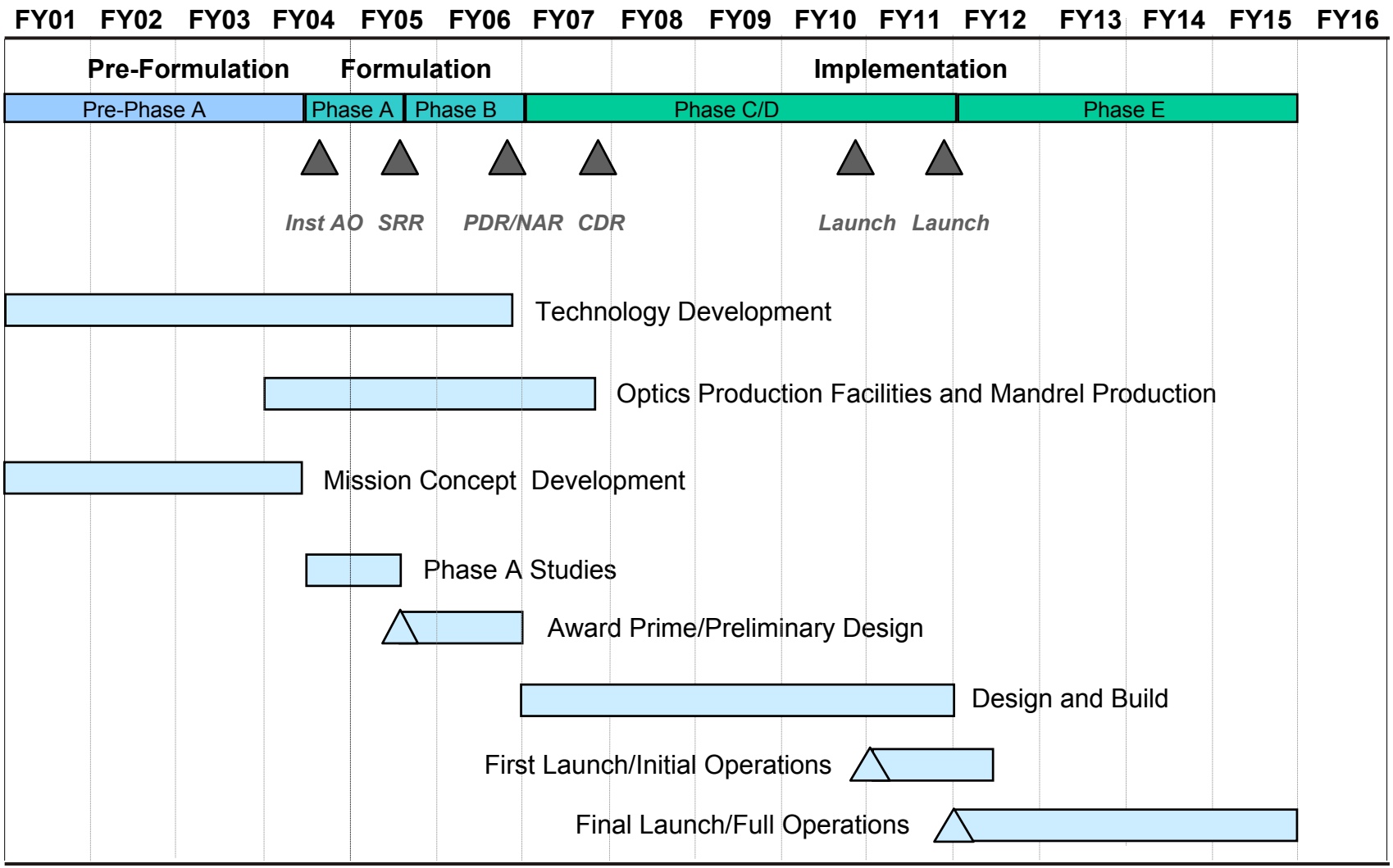
HXT Technology Roadmap



HXT Critical Technology Milestone

- **Hard X-ray Multilayer Mirror Protytype Completed and Tested in X-rays**
  - Angular resolution $\leq$ 1 arc minute (Half Power) Diameter at 20 keV.
  - Mass and reflectance consistent with the baseline mission requirements.
  - Multilayer mirror fabrication process verified.

Constellation-X Top Level Schedule



Acronym List

ADR	Adiabatic Demagnetization Refrigerator
CCD	Charge-Coupled-Device
HXT	Hard X-ray Telescope
NTD	Neutron-Transmutation-Doped
RGCCD	Registive Gate Charge-Coupled-Device
SXT	Spectroscopy X-ray Telescope
TES	Transition-Edge Sensors
TPF	Terrestial Planet Finder